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(54) BELL END OF A BELL AND SPIGOT JOINT AND METHOD OF MAKING THE SAME

(57) The bell end of a bell and spigot joint is disclosed herein and includes an end section 12 of a plastic pipe 14, an axially extending circumferential insert 16 located concentrically within this end section, and a circumferential sealing gasket 20 located within a groove in the inner surface of the insert. The insert 16 is held in place by a bonding material, e.g. an acrylic adhesive or a flexibilized polyvinyl chloride, which may be applied uniformly between the confronting surfaces of the inset 16 and the end section 12, or in the form of two circumferential strips 18. Heat is applied during the bonding process either by use of induction coils or by friction occasioned by relative rotation between the insert and the pipe end.

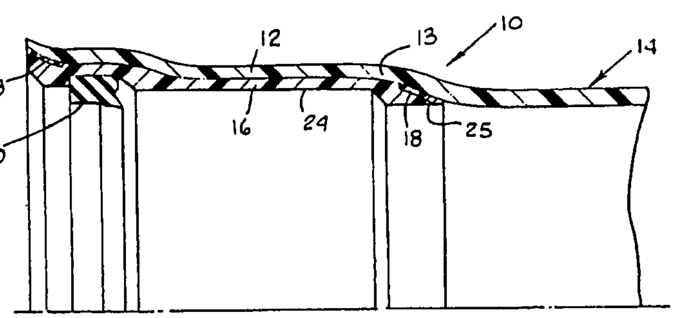

Fig 1

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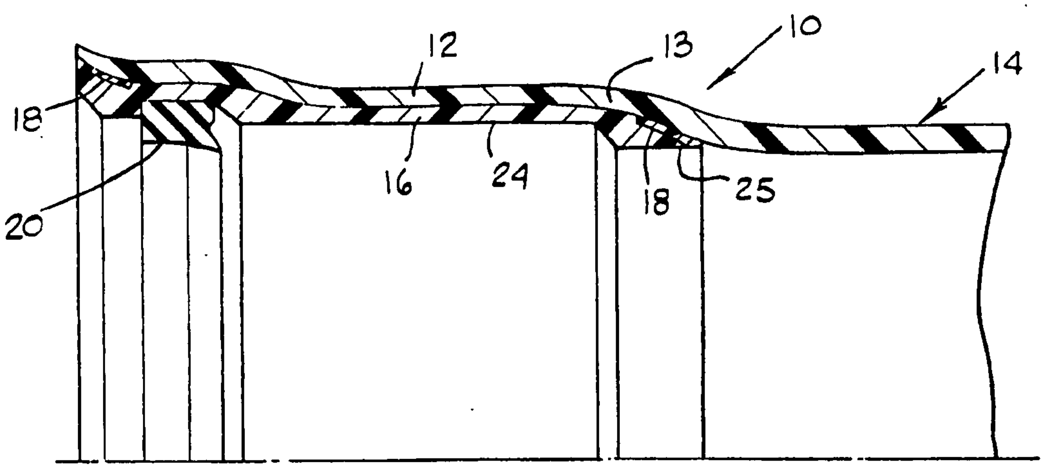

Fig. 1

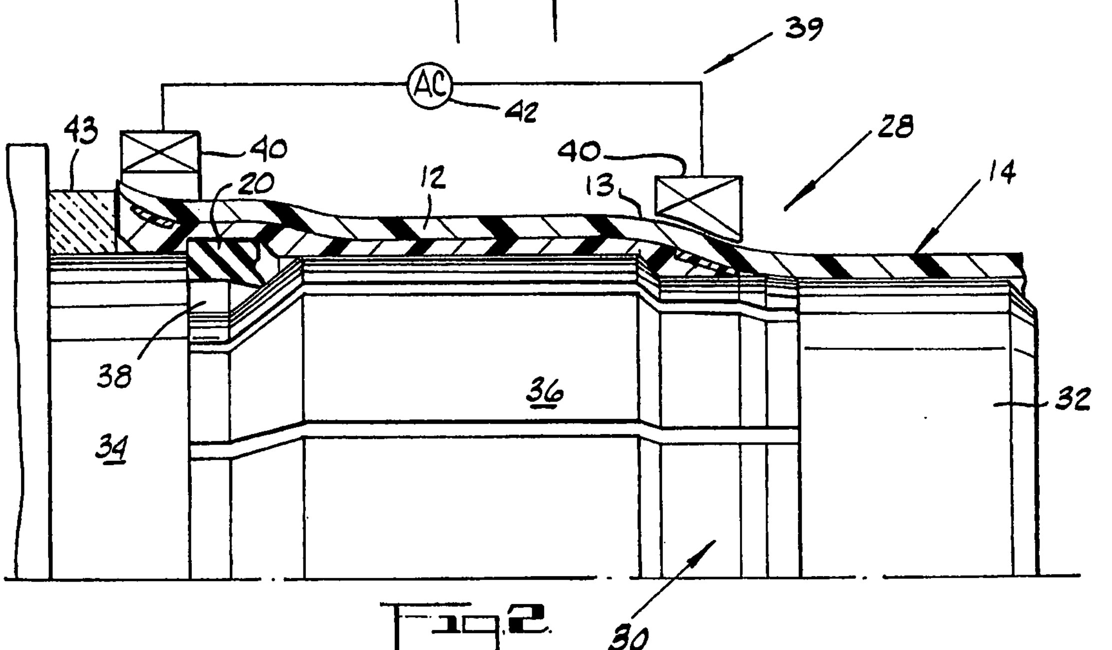

Fig. 2

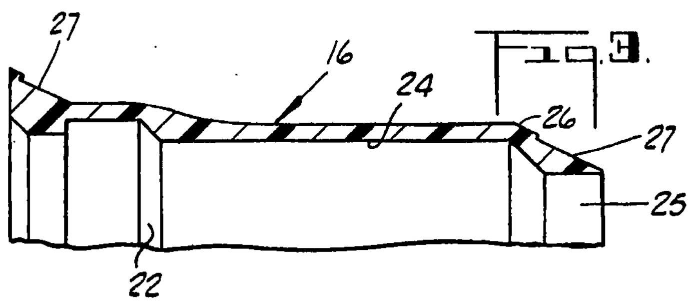

Fig. 3

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FIG. 4

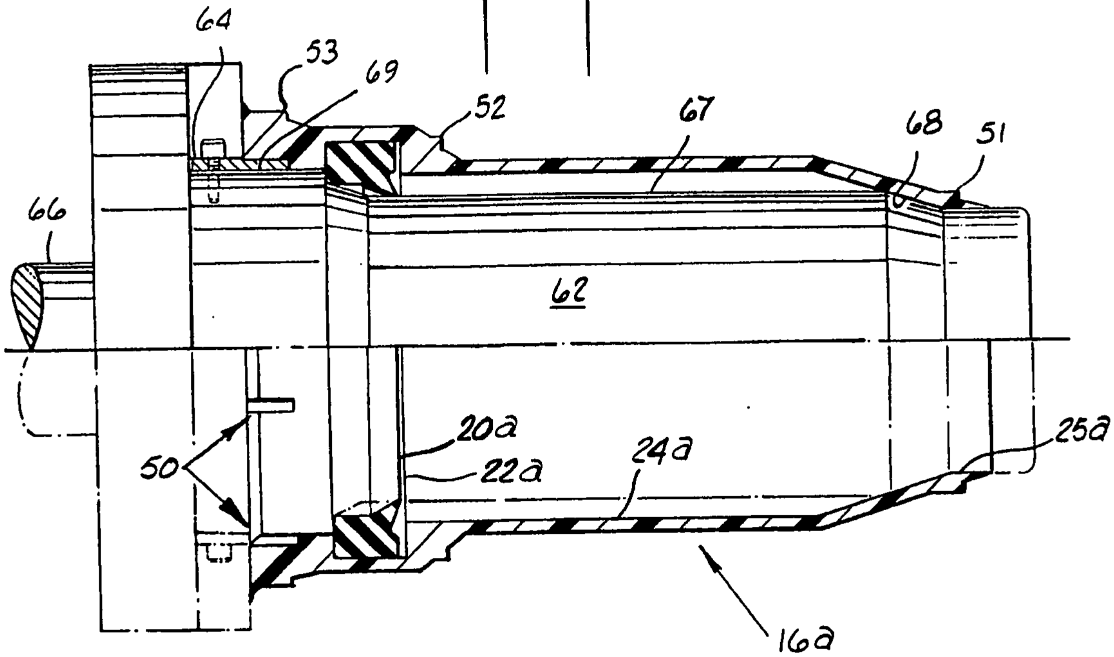


FIG. 5

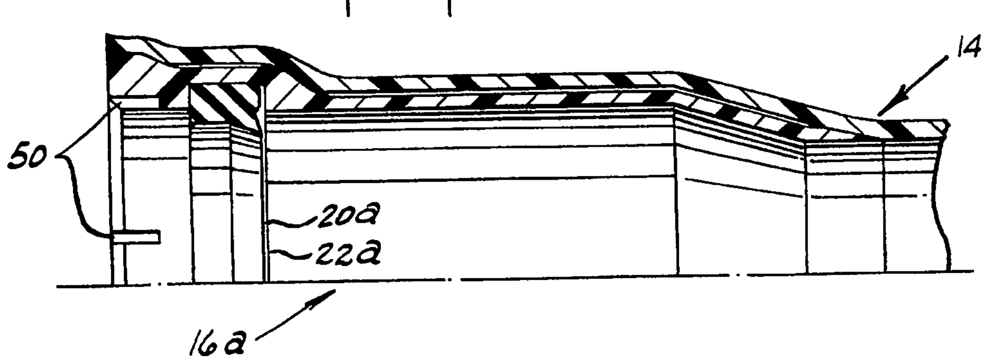
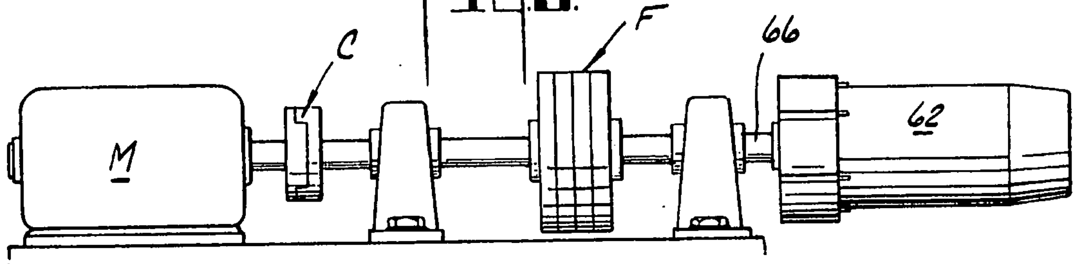


FIG. 6



SPECIFICATION

BELL END OF A BELL AND SPIGOT JOINT AND METHOD OF MAKING THE SAME

The present invention relates generally to the bell end of a plastic pipe joint and more particularly to a bell end designed for use in pressure service and to a method of making the bell end.

There are presently a number of conventional ways to manufacture the bell end of a bell and spigot joint from one end section of a plastic pipe, specifically a polyvinyl chloride (PVC) plastic pipe. In one such method, the end section of the pipe is first heated to its state of thermal deformability. While in this state, the heated end section is moved along and around a flared or bell shaped mandrel. In some cases an annular sealing gasket is positioned around the mandrel prior to forming the heated end section around the latter. In this way, a circumferential groove is formed in the bell end for housing the sealing gasket.

When the bell end just described is formed from an end section which is initially the same thickness as the rest of the pipe, the wall defining the resultant bell end will of course be thinner. This is perfectly satisfactory where the pipe joint including such a bell end is intended for use in nonpressure service. However, where the pipe joint is intended for use in pressure service, some specifications require that the wall defining the bell end be thicker in cross-sectional configuration than would be the case by belling the normal configuration of the pipe. One way to accomplish this is by thickening the end section of the pipe to be belled before belling takes place. This can be carried out during the actual extrusion of the pipe or it can be carried out after formation of the pipe.

As will be discussed in more detail hereinafter, the present invention is also directed to a pipe joint and particularly to a bell end intended for use in pressure service. However, the bell end constructed in accordance with the present invention is neither pre-thickened nor post-thickened but rather utilizes a rather unique combination of components to make it suitable for pressure service.

One object of the present invention is to provide an uncomplicated, economical and reliable bell end comprising part of a bell and spigot joint which is intended for use in pressure service.

Another object of the present invention is to provide a method of making this bell end in a way which does not require either pre-thickening or post-thickening one end section of a pipe.

Accordingly, the present invention provides a bell end of a bell and spigot joint comprising: an end section of said plastic pipe, said end section having a greater inner diameter than the rest of said pipe and having a wall of less thickness than said rest of said pipe; an axially extending circumferential insert positioned concentrically within said end section and against the inner surface thereof extending substantially the entire length of said end section, said insert having an inner diameter greater than said rest of said pipe, axially spaced ends, and including a concentric, circumferential groove for receiving a sealing gasket located in its inner surface and spaced from said axially spaced ends; and means for bonding said insert to said inner surface of said end section within said end section such that said insert adds thickness to said end section.

The present invention also provides a method of forming the bell end of a bell and spigot joint comprising: forming an axially extending circumferential insert having a groove for receiving a sealing gasket located in its inner surface; positioning said insert concentrically around and against the outer surface of a mandrel; heating an end section of a plastic pipe to its state of thermal deformability; moving said heated end section by relative movement of said end section and said mandrel along said mandrel and thereafter over and against the outer surface of said insert; providing means for holding said insert in place within said end section; cooling said end section to a temperature below its state of thermal deformability, whereby said end section shrinks tightly around said insert; and separating said cooled end section and insert from said mandrel.

Also provided in the present invention is a method of forming a bell end of a bell and spigot joint comprising: forming an axially extending circumferential plastic insert having a groove located in its inner surface and an outer surface having a predetermined contour with at least one circumferential protrusion; forming an enlarged end section on a plastic pipe such that said enlarged end section has an inner surface having a contour which approximates said predetermined contour of the outer surface of said insert; imparting to one of said insert and said enlarged end section a predetermined amount of rotational kinetic energy; bringing said at least one circumferential protrusion into frictional engagement with a corresponding portion of the inner surface of said enlarged end section such that said predetermined rotational kinetic energy is dissipated at said at least one protrusion in the form of heat; and permitting said heat to bond said insert in said enlarged end section in order to thicken said end section.

An apparatus for bonding an insert into an enlarged end section of a plastic pipe so as to thicken said end section is also provided in the present invention comprising: a motor; and a rotatable apparatus including a mandrel for holding said insert for mutual rotation thereon, said motor being capable of rotating said rotatable apparatus so as to impart thereto a predetermined amount of rotational kinetic energy, such predetermined amount being that which, when converted to heat energy by friction, is an amount adequate to bond said insert into said enlarged end section of plastic pipe when said insert is brought into frictional engagement with said enlarged end section.

The bell end constructed in accordance with the present invention is comprised in part of one end section of a plastic pipe, which end section has a greater inner diameter than the rest of the pipe. An axially extending circumferential insert is located

concentrically within this end section and against its inner surface. The insert is held in place by suitable means and includes a concentric, circumferential groove located in its inner surface, which groove is adapted to receive a circumferential sealing gasket, a portion of which extends out beyond the inner surface of the insert.

In one preferred embodiment of the present invention, the insert is held in place within the enlarged end section by two strips of bonding material, one of which circumscribes the outer surface of the insert at one end section thereof and the other of which circumscribes the outer surface of the insert at the opposite end section thereof. In an actual working embodiment of the present invention, this bonding material includes polyvinyl chloride, for example flexibilized PVC, having an electromagnetic composition, for example iron filings. However, the bonding material can be constructed of other suitable means, for example reaction cement or other chemical bonding cement.

In accordance with a preferred method of forming the bell end just described, the insert is first formed and positioned concentrically around and against the outer surface of a mandrel. The insert may or may not include the aforedescribed sealing gasket at this point in time. The previously described end section is heated to its state of thermal deformability and moved along the mandrel and thereafter over and against the outer surface of the insert. Means, for example the aforedescribed strips of bonding material, are provided for holding the insert in place and the end section is cooled to a temperature below its state of thermal deformability, whereby the end section shrinks tightly around the insert. Finally, the cooled end section and insert are separated from the mandrel and the sealing gasket is placed within the insert if this has not already been carried out.

In another preferred embodiment, the insert is held in place within the enlarged end section by frictionally bonding selected portions of the outer surface of the insert to the inner surface of the enlarged end section. The end section of the pipe is heated to its state of thermal deformability and forced over a forming mandrel. Thereafter the end section is cooled on this mandrel resulting in a precisely shaped enlarged end section. Meanwhile an insert having circumferential protrusions at selected locations on its outer surface is placed on a rotatable mandrel which incorporates a known rotational mass. This mandrel insert combination is caused to rotate at a predetermined rate. The enlarged end section is moved axially over the rotating insert causing the circumferential protrusions to bear firmly against portions of the inner wall of the enlarged end section. The rotational energy stored in the insert/mandrel system is transformed into frictional energy, or heat, at the interface between the circumferential projections and the inner surface of the enlarged end section. As the rotating motion is brought to a halt by this frictional engagement, precisely enough heat has been generated at the protrusions to melt these protrusions as well as some of the contiguous PVC material to bond the insert and the enlarged end section together. The insert and end sections are removed from the mandrel as a unit. Upon cooling, a dependable, mechanically strong, homogeneous bond is formed.

FIG. 1 is a frontal cross-sectional view of the bell end of a bell and spigot joint, which bell end is constructed in accordance with the present invention.

FIG. 2 is a frontal cross-sectional view of an assembly utilized in the formation of the bell end illustrated in FIG. 1.

FIG. 3 is a frontal cross-sectional view of one component of the bell end of FIG. 1.

FIG. 4 is a sectional view of an assembly utilized to frictionally bond another form of the present invention.

FIG. 5 is a sectional view of a bell end which has been frictionally bonded.

FIG. 6 is a schematic showing of the system for spinning the assembly shown in FIG. 4.

Turning now to the Drawings, wherein like components are designated by like reference numerals throughout the various Figures, attention is first directed to FIG. 1 which illustrates the bell end 10 of a bell and spigot joint, formed in accordance with the present invention. As illustrated in FIG. 1, bell end 10 includes an end section 12 of a plastic pipe 14, a tapering section 13 joining end section 12 to the rest of the pipe, an axially extending circumferential insert 16, means 18 for holding the insert in place within end section 12, as will be described in more detail hereinafter, and a circumferential sealing gasket 20.

Pipe 14 may be of any suitable cross-section and may be constructed of any plastic material. However, in an actual working embodiment of the present invention, the pipe's cross-section is circular and it is constructed of polyvinyl chloride which may or may not include fillers. As illustrated in FIG. 1, end section 12 is enlarged relative to the rest of the pipe, that is, it has a greater inner diameter. In this regard, it should be noted from FIG. 1 that the wall defining end section 12 is somewhat thinner in cross-section than the rest of pipe 14. This is a result of the preferred way in which enlarged end section 12 was formed. More specifically, the undeformed end section of pipe 14, having the same wall thickness as the rest of the pipe was actually deformed outwardly to form enlarged end section 12, without decreasing its length and thereby thinning it out. Because of this relative thinness of end section 12 compared to the wall thickness of the rest of pipe 14, the end section may not be suitable for use as a bell end, in and by itself particularly where the bell end is intended for use in pressure service. However, in accordance with the present invention, " thickness " is added to this end section in an uncomplicated, economical and reliable way, specifically by means of insert 16, thereby making bell 10 suitable for pressure service.

Turning to FIG. 3, attention is directed to insert 16 which is constructed of any suitable material which can be readily held in place within end section 12 and is formed in any suitable manner. However, in a preferred embodiment of the present invention, the insert is constructed of polyvinyl chloride and is injection molded into the shape illustrated. As

illustrated, the insert is formed with a concentric, circumferential groove 22 located in its inner surface 24. This groove is adapted to receive an outer circumferential portion of sealing gasket 20 while an inner circumferential portion thereof projects radially inward beyond innermost surface 24, as illustrated in FIG. 1. The groove may be designed to receive the gasket in a rather tight locked-in fashion so that the gasket does not have to be bonded in place or, as illustrated, the groove can be selected to require bonding. In this latter case, where bonding is required, any suitable bonding material such as polyurethane adhesive can be utilized.

Returning to FIG. 1, it can be seen that insert 16 fits tightly within enlarged end section 12 such that the outer surface of the insert and the inner surface of the end section are in close confronting relationship with one another. In this regard, the insert preferably extends the entire length of end section 12 and includes a tapered back end (26 (FIG. 3) which approximately conforms with the inner surface of transverse section 13 joining end section 12 with the rest of pipe 14. The insert may be held in place by any suitable means including a reaction cement such DuPont's 2 part Acrylic adhesive sold under for example " CAVALON " and made available by H. B. Fuller Company. In a preferred embodiment of the present invention, a flexibilized polyvinyl chloride which is applied in a manner to be described hereinafter is utilized.

The bonding material selected may be provided uniformly between and along the entire confronting surfaces of insert 16 and end section 12. However, in accordance with the present invention, a first circumferential strip of bonding material (indicated at 18) is provided around the outer surface of the insert, actually between the insert and end section, at or near one end of the insert and a second circumferential strip of the same bonding material (also indicated at 18) is provided around the outer surface of the insert, again actually between the insert and end section, at or adjacent the other end of the insert. While the bonding material may be applied directly to the outermost surface of insert 16, in a preferred and actual working embodiment of the present invention, the insert includes circumferential grooves 27 located in the outer surface of insert 16 at or adjacent to the ends of the insert, as illustrated in FIG. 3. These grooves are adapted to receive bonding material 18. In this regard, in an actual working embodiment of the present invention, the bonding material selected is the previously recited flexibilized polyvinyl chloride having iron filings distributed therethrough. However, it is to be understood that any suitable PVC, including an electromagnetic composition, can be used. The preferred bonding material in the working embodiment is in the form of strips which fit within and fill grooves 27 as illustrated in FIG. 3.

From the foregoing, it should be apparent that bell end 10 is adapted to receive a spigot end, that is, the undeformed end of a plastic pipe identical to pipe 14. In this regard, it should be noted that the diameter of inner surface 24 of insert 16 is greater than the outer diameter of undeformed pipe 14. Diameter 25 (inner surface of tapered end of insert) is also greater than the inner diameter of the undeformed pipe. However, as stated previously, gasket 20 projects inwardly beyond inner surface 24 and extends beyond the outer surface of undeformed pipe 14. In this manner, the spigot end of the bell and spigot joint can be readily assembled into the bell end and yet the sealing gasket 20 can provide a reliable seal between the bell end and spigot.

Having described bell end 10, attention is now directed to FIG. 2 which illustrates an assembly 28 utilized in a preferred method of making the bell end. As indicated in FIG. 2. this assembly includes an axially extending, cylindrical mandrel 30 of a nonferrous material, for example bronze or copper, having a rearward section 32, a forwardmost section 34 and collapsible intermediate section 36 joining the rearward and forward section. Section 36 is preferably made of six segments having small gaps therebetween in its expanded condition as shown. These segments are moved towards one another by known means thus closing these gaps and reducing the effective diameter of section 36. This permits the mandrel to be easily axially extracted after insert 16 has been bonded in place as will be set forth more fully. As indicated, rearward section 32 has an outer diameter approximately equal, actually slightly smaller, than the inner diameter of undeformed pipe 14. Forwardmost section 34 has an outer diameter which is equal to (actually slightly larger than) the outer diameter of undeformed pipe 14 and hence equal to (or slightly larger than) the outer diameter of the spigot end of the pipe joint including bell end 10. Section 36, of course, tapers in two steps outwardly from rearward section 32 to forward section 34. The mandrel may or may not include a circumferential recess 38 positioned in and concentrically around the outer surface of forward section 34, near the front end thereof. Where the sealing gasket 20 is prepositioned within groove 22, as will be described in more detail hereinafter, the recess may be necessary. On the other hand, where the gasket is not positioned within groove 22 until formation of end section 12 about insert 16, as will also be described hereinafter, recess 38 is not necessary.

Where the particular bonding material 18 selected to bond insert 16 in place within enlarged end section 12 of pipe 14 is PVC with electromagnetic composition, assembly 28 requires the utilization of means to excite the electromagnetic material. Such means includes a copper induction coil (or coils located adjacent the bonding material and a source of AC power connected to the coil (or coils) to energize the latter. This AC powder produces a fluctuating magnetic field across the bonding material which in turn excites the electromagnetic material, for example the iron filings, and causes the PVC to bond. As illustrated in FIG. 2, two such coils, specifically coils 40, are positioned concentrically around the outer surface of end section 12 adjacent bonding material 18. Electrical insulation means 43 may be desirable or necessary between the coils and mandrel

to prevent shorting the two out. A suitable AC source 42 is shown schematically connected to the two coils. The exact positional relationship between the bonding material and the coils and the exact amount and type of power required to excite the electromagnetic material within the bonding material can be readily determined by those skilled in the art. Of course, where the bonding material is not PVC with electromagnetic material, assembly 10 will not require the elaborate means just described.

Having described assembly 28, attention is now directed to one of Applicants' preferred methods of forming bell end 10. One step in this method requires that the insert 16 be formed. As stated previously the insert can be provided in any suitable way but is preferably injection molded to the shape described previously. Once formed, circumferential sealing gasket 20 may be prepositioned within groove 22 and bonded in place if necessary or this step can be carried out later in the overall sequence. In any case, the insert, with or without the gasket in place, is positioned concentrically around and against the outer surface of mandrel 30, specifically along front section 34 of the latter. In the event that the gasket 20 is prepositioned within groove 22 of the insert, previously described recess 38 is provided within the mandrel and that portion of the gasket projecting inwardly from the insert is positioned within the recess.

Having positioned insert 16 around mandrel 30 in the manner described, bonding material 18 is located within grooves 27, that is, if the bonding material has not already been applied. The end section of plastic pipe 14 is heated to its state of thermal deformability utilizing conventional means (not shown) and carried out in a conventional way by those with ordinary skill in the art. After the end section has been so heated, it is moved by relative movement of the end section and mandrel along the latter and thereafter over and against the outer surface of insert 16. Conventional means (not shown) can be readily provided for carrying out this relative movement.

Where the particular bonding material selected is the type requiring excitation means 39, these means are now utilized to provide the appropriate bonding. After this has been accomplished, end section 12 is allowed to cool to a temperature below its state of thermal deformability. In this way, the end section shrinks tightly around the insert, especially where grooves 27 have been provided in the latter so that the bonding material does not project outwardly beyond the outer surface of the insert. Thereafter, section 36 is collapsed and mandrel 30 is separated from the formed bell end. If gasket 20 has not already been positioned in groove 22, it is provided at this time.

Applicants have discovered a further system for providing a " thickened " bell portion in pressure pipe similar to that shown in FIG. 1, but which eliminates the relatively complex bonding arrangement as shown in FIG. 2. This bonding system utilizes an insert 16a as shown in FIG. 4. Insert 16a is very similar to the insert shown in FIG. 3 in that it is also made of a polyvinyl chloride material by an injection molding process. Preferably this material is the same material utilized in the formation of the pipe 14 into which the insert is bonded. Insert 16a, as does insert 16, includes a circumferential groove 22a which holds sealing gasket 20a in a manner similar to which sealing gasket 20 is held (i.e. either by a urethane type adhesive or in a mechanically locked in fashion). Inner surfaces 24a and 25a have dimensional considerations corresponding to the equivalent surfaces in insert 16 such that the inner surface (with the exception of indentations 50 whose functions will be more fully described below), is substantially identical to the inner surface of insert 16.

The outer surface, that is the surface which will later be bonded to the inner surface of the enlarged end section 12 of PVC pipe 14, differs considerably from that of insert 16. Rather than circumferential indentations 27 and 27 of FIG. 3, insert 16a includes circumferential protrusions 51, 52 and 53. Each protrusion is shown as having a generally triangular cross-section, with a generally cylindrical side extending from an outwardly projecting corner axially towards indentations 50 and another side extending generally radially inward along an annular surface from the projecting corner towards the axis of the insert. These circumferential protrusions are of course integrally molded into the outer surface of insert 16a and comprise no more than extensions of the thermoplastic material making up the body of insert 16a.

Preferably the spigot receiving opening of insert 16a includes six equally spaced indentations 50. As shown in FIG. 4, indentations 50 comprise generally rectangular cavities extending from a generally frusto-conical edge of a spigot receiving end and extend a substantial portion of the distance from this frusto-conical edge to the preformed ring groove 22a. The operation of indentations 50 becomes apparent when they are interrelated to spinning mandrel 62 as shown in FIG. 4. Spinning mandrel 62 essentially consists of a preferably solid massive metal mandrel mounted on shaft 66. Mandrel 62 includes indentation engaging lugs 64. While lugs 64 could be integrally formed with mandrel 62, FIG. 4 shows them as being removably attached in radially extending slots. Mandrel 62 is dimensioned so as to engage insert 16a such that insert 16a can be rotated along with massive mandrel 62. Mandrel 62 has a generally cylindrical surface 67 which is spaced radially inward from the corresponding portion of insert 16a. To one end of cylindrical section 67 is another cylindrical section 69 which supports lugs 64 and positions the spigot receiving end of 16a for precise rotational motion with mandrel 62. Sealing gasket 20a aids in holding insert 16a on mandrel 62, since cylindrical portion 67 is dimensioned so as to cause a minor outward deflection of the sealing edge of sealing gasket 20a such that the sealing gasket grips the cylindrical portion 67.

Frusto-conical portion 68 extends between the cylindrical portion 67 and terminal end of mandrel 62 and firmly abuts the corresponding portion of insert 16a in order to support that portion of the

insert and prevent radially inward deflection during the spin-bonding operation at circumferential protrusion 51. This has been found necessary since the wall of insert 16a supporting protrusion 51 is rather thin in order to permit a smooth streamlined transition between the pipe and the insert in the completed bell end.

The end of pipe 14 is enlarged in a known manner by heating the end to its state of thermal deformability and thrusting this heated end over a forming mandrel to enlarge the diameter in order to receive insert 16a. The enlarged end section of pipe 14 is so dimensioned so as to engage circumferential protrusions 51, 52 and 53 when the enlarged end section of pipe 14 is thrust over insert 16a as it rotates with spinning mandrel 62. While pipe 14 is being formed as outlined above, spinning mandrel 62 has been brought to a predetermined rotational rate. This rotational rate is such that in the overall freely rotating system of massive mandrel 62, shaft 66 and, if necessary, a rotating flywheel, contains a predetermined amount of rotational kinetic energy. This amount of rotational kinetic energy is such that a precisely controlled and adequate amount of heat is generated when the rotational inertia is frictionally resisted by the engagement of circumferential protrusions 51, 52 and 53 by the inner surface of the enlarged end section of pipe 14. Put another way, it can be seen that when rotating mandrel 62, with insert 16a positioned thereon as shown in FIG. 4, is permitted to freewheel (along with an attached flywheel), the overall rotating system has stored therein an easily determined amount of kinetic energy in the form of rotational kinetic energy. Pipe 14, with its enlarged end section is firmly held by for example hydraulically operated jaws. Thus, when the enlarged end section is axially moved to encompass the rotating insert 16a, the circumferential protrusions 51, 52 and 53 impinge on and rotate against the inner surface of the enlarged end section. This frictional engagement dissipates the rotational kinetic energy in the form of heat caused by friction. Frictional heat causes the circumferential projections 51, 52 and 53 to melt the corresponding portions of the enlarged end section of pipe 14. Simultaneously, the circumferential projections 51, 52 and 53 melt. The rotational rate of the spinning mandrel 62 can be made such that when the overall system comes to a halt, i.e. when all rotational energy has been transformed to thermal energy at the protrusions 51, 52 and 53, the proper amount of melting at these locations has taken place such that a complete and dependable bond has formed between the insert and the enlarged end section of pipe 14 as shown in FIG. 5.

The mandrel 62 and associated rotating parts are shown in FIG. 6. Motor M can be any ordinary electric motor of horsepower adequate to bring the rotating system up to the proper rotational rate in a reasonable period of time. Clutch C interconnects motor M to flywheel F and mandrel 62. Clutch C is necessary only if motor M is of the type which would apply a braking force to the rotating system once power is removed. Flywheel F, as stated previously, may not be necessary if mandrel 62, shaft 66 and motor M have together adequate mass to store the requisite rotational kinetic energy. The operation of the system shown in FIG. 6 is quite simple. Motor M is provided electrical power and the overall rotating system (i.e. mandrel 62, shaft 66, flywheel F (if any), clutch C (if any) and motor M) is allowed to reach the optimum rotational rate. Once achieved, this rate is maintained by motor M until just prior to engaging rotating insert 16a with pipe 14. It is necessary to remove any power to motor M (or to disengage clutch C) in order to permit the mandrel to freewheel since all the rotational kinetic energy stored in the rotating system, no more and no less, is to be transformed to heat at the circumferential protrusions 51, 52 and 53. If motor M continued to apply power to mandrel 62, the amount of heat generated would cease to be related substantially solely on stored kinetic energy. Other process variables would thus affect the amount of heat generated and the dependability and consistency with which the bonding takes place would be adversely affected.

The above outlined bonding system has the advantage of using the same material to bond that is used to form the insert 16a, thus eliminating all other extraneous material which might have different physical characteristics. Also, of course, the insert 16a, and thus all circumferential protrusions 51, can be made of the same thermoplastic material, preferably polyvinyl chloride, as is pipe 14. The use of the same material for all portions of the thickened, belled pipe has the advantage in that this material, (namely PVC), has known characteristics and has been proven to be acceptable to all authorities for such field service as has traditionally been performed by PVC pipe. Secondly, all pipes of the system, being of the same material, would react in a similar manner to physical and thermal stresses and thus there would be less chance of the bond weakening due to these stresses.

The outlined spin-bonding process is quite simple and easily adapted to mass production. Process variables, such as the rotational rate of spinning mandrel 62 can easily be determined. Once determined this rotational rate can easily be monitored and consistantly attained on the production line, leading to dependable bonding of selected circumferential areas at the interface between the insert 16a and the enlarged end of pipe 14.

While three circumferential protrusions 51, 52 and 53 are shown, it is to be understood that not all three protrusions may be necessary for all applications of the instant invention. For example, circumferential protrusion 51 may be the only one necessary for some instances, since when properly bonded insert 16a will be held mechanically by the frictionally melted portion at the location of 51, nor will fluids contained in pipe 14 be able to leak past the seal formed by the bonded portion at the location of 51. In situations where the spigot receiving end of insert 16a must be

bonded to the inner surface of enlarged end portion, circumferential protrusion 53 may be necessary also to effect such bond.

CLAIMS

1. A bell end of a bell and spigot joint comprising: an end section of said plastic pipe, said end section having a greater inner diameter than the rest of said pipe and having a wall of less thickness than said rest of said pipe; an axially extending circumferential insert positioned concentrically within said end section and against the inner surface thereof extending substantially the entire length of said end section, said insert having an inner diameter greater than said rest of said pipe, axially spaced ends, and including a concentric, circumferential groove for receiving a sealing gasket located in its inner surface and spaced from said axially spaced ends; and means for bonding said insert to said inner surface of said end section within said end section such that said insert adds thickness to said end section.

2. A bell end as defined in Claim 1 wherein said means for bonding said insert includes polyvinyl chloride having an electromagnetic composition which has melted selected portions of said inner surface so as to form a bond in response to said composition absorbing electromagnetic energy.

3. A bell end as defined in Claim 2 wherein said polyvinyl chloride is flexibilized polyvinyl chloride and wherein said composition is iron filings.

4. A bell end as defined in any of Claims 1—3 wherein said means for bonding includes a first circumferential strip of bonding material circumscribing the outer surface of said insert at one end section thereof and a second circumferential strip of said bonding material circumscribing the outer surface of said insert at the opposite end section thereof.

5. A bell end as defined in any of Claims 1—4 wherein said insert includes first and second coaxial, circumferential grooves located within its outer surface at said end sections, respectively, said first and second strips of material being located within said grooves.

6. A bell end as defined in any of Claims 1—5 wherein said bonding material includes polyvinyl chloride having an electromagnetic composition which has melted selected portions of said insert and said inner surface of said end section adjacent said bonding material.

7. A bell end as defined in any of Claims 1—6 wherein said bonding material includes reaction cement.

8. A bell end as defined in any of Claims 1—7 wherein the outer surface of said insert and the inner surface of said pipe end section, between said strips of bonding material are in direct contact with each other.

9. A bell end as defined in any of Claims 1—8 wherein said means for bonding said insert includes at least one circumferential protrusion which has melted selected portions of said inner surface of said end section.

10. A bell end as defined in any of Claims 1—9 wherein said groove has a circumferential sealing gasket located therein, a portion of said gasket extending out beyond the inner surface of said insert.

11. A method of forming the bell end of a bell and spigot joint comprising: forming an axially extending circumferential insert having a groove for receiving a sealing gasket located in its inner surface; positioning said insert concentrically around and against the outer surface of a mandrel; heating an end section of a plastic pipe to its state of thermal deformability; moving said heated end section by relative movement of said end section and said mandrel along said mandrel and thereafter over and against the outer surface of said insert; providing means for holding said insert in place within said end section; cooling said end section to a temperature below its state of thermal deformability, whereby said end section shrinks tightly around said insert; and separating said cooled end section and insert from said mandrel.

12. A method as defined in Claim 11 wherein said step of providing means for holding said insert in place includes applying a first strip of bonding material around the outer surface of said insert at one end section thereof and a second strip of said bonding material around the outer surface of said insert at the opposite end section thereof, said strips being applied prior to moving said end section over said insert.

13. A method as defined in Claims 11 or 12 wherein said bonding material includes polyvinyl chloride having an electromagnetic composition, wherein said mandrel is constructed of nonferrous material and wherein the method includes exciting said electromagnetic material by means of a magnetic field whereby to bond said polyvinyl chloride to said insert and heated end section.

14. A method as defined in any of Claims 11—13 further including the step of positioning a circumferential sealing gasket within said insert groove.

15. A method of forming a bell end of a bell and spigot joint comprising: form an axially extending circumferential plastic insert having a groove located in its inner surface and an outer surface having a predetermined contour with at least one circumferential protrusion; forming an enlarged end section on a plastic pipe such that said enlarged end section has an inner surface having a contour which approximates said predetermined contour of the outer surface of said insert; imparting to one of said insert and said enlarged end section a predetermined amount of rotational kinetic energy; bringing said at least one circumferential protrusion into frictional engagement with a corresponding portion of the inner surface of said enlarged end section such that said predetermined rotational kinetic energy is dissipated at said at least one protrusion in the form of heat; and permitting said heat to bond said insert in said enlarged end section in order to thicken said end section.

16. An apparatus for bonding an insert into an enlarged end section of a plastic pipe so as to thicken said end section comprising: a motor; and a rotatable

apparatus including a mandrel for holding said insert for mutual rotation thereon, said motor being capable of rotating said rotatable apparatus so as to impart thereto a predetermined amount of rotational kinetic energy, such predetermined amount being that which, when converted to heat energy by friction, is an amount adequate to bond said insert into said enlarged end section of plastic pipe when said insert is brought into frictional engagement with said enlarged end section.

17. A bell end of a bell and spigot joint substantially as described in the specification and accompanying drawings.

18. A method of forming a bell end of a bell and spigot joint substantially as described in the specification and accompanying drawings.

19. An apparatus for bonding an insert into an enlarged section of a plastic pipe so as to thicken said section substantially as described in the specification and accompanying drawings.

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